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Lipschütz were unsuccessful, but his colleague, Dr. Löwenstein, secured a growth of the organism from an inoculated animal.

Extensive cultural and inoculation experiments left no doubt that the organisms were those of avian tuberculosis.

The organisms were slightly pathogenic for rabbits and guinea pigs but markedly so for fowls. Success in inoculating the latter together with the characteristics of the cultures made the nature of the infection clear.

Comment.—The nature of the lesions, the chronicity of the disease, and the results of the microscopical examinations would be in agreement with leprosy, and only exhaustive animal inoculations and cultural tests would serve to establish the diagnosis. Perhaps the point to emphasize especially is that the presence of large numbers of acid-fast and alcohol-fast bacilli may be found in a disease other than leprosy. In size, number, staining reactions, and location, the organisms, as shown by the illustrations accompanying the article, would pass anywhere as those of leprosy.

IMPOUNDED WATERS.

THEIR EFFECT ON THE PREVALENCE OF MALARIA—SURVEY AT BLEWETTS FALLS.

By H. R. Carter, Senior Surgeon, United States Public Health Service.

Under bureau instructions a survey was made of the pond of the power plant at Blewetts Falls, N. C. This survey was undertaken as part of the field investigation of malaria, and its object was to determine the relations of this pond to the breeding of Anopheles mosquitoes.

It is intended that this work shall form part of a general investigation of the effect of impounded waters on the incidence of malaria, involving the survey of a number of other ponds and leading, we hope, to the determination of the conditions about the pond which affect the production of malaria, and finally of the measures to be taken for producing the best sanitary conditions possible about the pond. Such an investigation should be spread over four or five years. Another paper discusses the general features of the problem and its importance. (Public Health Reports, Dec. 25, 1914, p. 3458.)

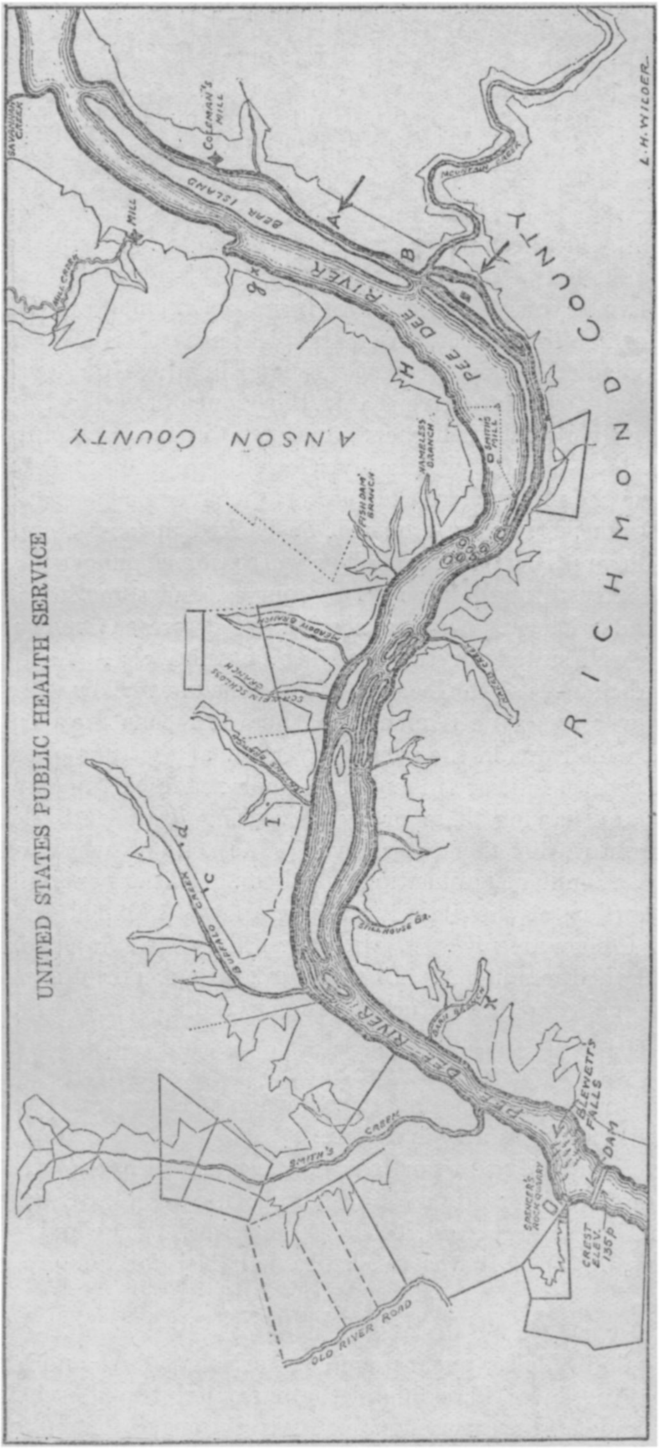
The determination of the production of Anopheles mosquitoes rather than the production of malaria was the immediate object of this inquiry. The latter requires consideration not only of mosquitoes—malaria vectors—but people accessible to them—i. e., residing within their distance of flight. This part of the problem was not touched, and our conclusions will involve the incidence of malaria from the breeding places found only if people are living within the limits of flight from such breeding places. This limitation of investigation was made purposely, so that a more thorough investigation of the pond as a producer of Anopheles mosquitoes could be made. It was the first large pond to be so studied and we wished to learn all we could from it so as to know better how to examine the next pond we undertook. Therefore we did not limit our study to the portions of the pond adjacent to residences, which would have been an extremely small portion of it.

Two surveys were made, one during the last two weeks in July and one during the last two weeks in September. Each was a fairly complete survey—physical and biological—of the whole pond. The object of doing this work twice was that the pond might be seen under different conditions. In July the water was high, 139.4 feet on the gauge, when the survey began, and very muddy. In September it was low, 135 to 131.4 feet, and as clear, I suppose, as this river, the Pedee, ever is. For making both surveys the party included Sanitary Engineer Le Prince, Asst. Surg. Derivaux, and myself. In July we were assisted by Mr. Lamb, a field engineer, who had established the contour of flowage; in September by Mr. M. B. Mitzmain, biologist, Public Health Service, a most valuable addition to the party; Surg. von Ezdorf was also with the party for a short time. The power company furnished us a launch and did everything possible to facilitate our work.

Blewetts Falls is in North Carolina, on the Pedee River, a few miles from the southern border of the State. The dam raises the water about 35 feet, and can be raised by flush boards 3½ feet higher. It is generally high in the late winter, spring, and early summer, and low in midsummer and fall. With water at 137 to 138 feet elevation it is about 8 miles long, Coleman's mill being considered the head of backwater. Its general direction is north and south.

The conformation of the river valley in this section is that given in "Impounded water—some general considerations on its effect on the prevalence of malaria" (Public Health Reports, Dec. 25, 1914), to which the reader is referred and which should be read before and in connection with this paper. The country was cut by ridges, many of them high, that ran east and west across the river. The north side of the ridge was almost invariably very steep, while to the south the slope was gentle, especially at the base. Under these ridges the larger creeks ran, the steep ridges forming their southern banks. As a result the southern shores of the bayous were nearly always steep, while the northern shores were gently sloping. There were a few points where this was not true. Next the dam the pond stretched a solid sheet of water, except for one small island, for about 5 miles up, covering flats and the beds of creeks, and filling up ravines and creek valleys in long indentations—bayous. The pond in this

UNITED STATES PUBLIC HEALTH SERVICE



Map of property of the Rockingham Power Co. on Pedee River, Anson and Richmond Counties, N. C.

section filled the valley from hill to hill and there were no sloping banks except up in the bayous. It was one-half mile to 1 or 1¼ miles wide. The plat submitted, copied by Asst. Surg. Waller from one belonging to the power company, is intended to show (1) the normal river before the pond was made and (2) the 150-foot contour in the river valley. This was taken as the flowage contour, but was 10.6 feet higher than the maximum flowage as we saw it and 4 or 5 feet higher than it has been since the pond was made. This plat is inaccurate in that between the mouth of Smiths Creek and the forebay there are five bayous filling ravines, from which small streams enter the pond, which are not shown on the plat; otherwise it is correct.

We have called that portion of the pond in which the level of the water is about that of the river banks the "zone of overflow." As the bank at the river's edge is higher than the flat at the back of it—when there is a flat—this flat will be overflowed here and even some distance above the place where the bank at the river's edge is still above water. Drains, branches, etc., will be backed up and there will be considerable areas covered by shallow water, some connected with the river indirectly through these water courses, and some left as pools unconnected with it. Such a section must present many places physically well suited for the breeding of Anopheles. As the level of the pond changes so the location of the zone of overflow will change, and whenever this zone is mentioned here it means the part of the pond area which was in the zone of overflow at the time of examination. Of course, in it are included all pools made by the pond either by falling and leaving them or by preventing drainage by lessening seepage from raising the water level. The zone of overflow for the creeks has a similar signification for them. The upper limit of the zone of overflow at the highest water we saw—139 feet—came not far below Coleman's mill. During our July visit it was from that point to about the point A. During our September visit it was from about this point to B, fluctuating widely as the pond rose and fell between Saturday and Monday.

The largest bayou was that of Smiths Creek, about 1½ to 2 miles long to backwater and one-fourth mile wide at the entrance, and this was studied closely as a type bayou.

Trees were standing in portions of the pond and trees and brush in many of the bayous, especially high up; i. e., distant from the old river bed. These were dead, killed by the water. The pond was filled in January, 1912, so it was two and one-half years old at our July inspection.

Survey of Normal River Valley.

It being desirable for purposes of comparison to have an idea of the mosquito (Anopheles) breeding of the normal river valley before the dam was made, a survey was made of two sections of the valley—each a little less than a mile long—one beginning a mile above backwater and running upstream and the other beginning one-half mile below the dam and running downstream. These surveys were carried to the 120 or 130 foot contour, as near as we could judge, and thus embraced such territory as would have been covered by the pond within, say, 2 or 3 miles of the dam.

Below the dam this territory was breeding Anopheles profusely over a wide extent of marshy flat used as a pasture. It was breeding much less above the pond. The country here was very sparsely settled and stock of any kind was scarce, and while places physically suited for breeding were common and a number of them were breeding, yet only a small proportion of them were breeding freely. We thought this probably due to the absence of convenient blood supply. The only place breeding profusely was in a pasture containing hogs. Others breeding fairly were not far from houses and at crossing places of creeks. A similar examination in September below the dam gave the same results—profuse breeding—but equally profuse above the dam and on both sides of the river. On this case we took a somewhat different section, beginning near backwater and going up the river.

Without exception, every creek emptying into the pond was found to be breeding Anopheles well above the influence of the pond; in marshes by their sides; in side pools from overflow, and in still places under hammocks in the creeks themselves. The same was true, although with some exceptions, of the branches. Some streams, as Smiths, Buffalo, Mill, and Naked Creeks, and Barn and Jenkins Branches, were breeding profusely. Some branches were not breeding at all. The creeks were breeding less near backwater than well above it—due to the much larger number of small fish in the former section. Indeed, fish were congregated at the entrance of the creek into the pond and evidently ascended the creeks from this backwater and were left in many of the side pools of this section as the pond fell. Except Mountain Creek the creeks were singularly free of fish well above backwater.

As the small streams which emptied into the pond some distance from the dam were practically all breeding Anopheles in that portion of their beds which would have been submerged had the stream emptied into the river closer to the dam, it is fair to say that those which did so empty into the river close to the dam formerly bred Anopheles in places now covered by the pond. (See p. 3458, Public Health Reports, Dec. 25, 1914, Impounded Water, etc.)

The conclusion reached, then, is that the valley now occupied by this pond formerly bred Anopheles, and bred them over a large area and freely and in places profusely. This deduction to me seems inevitable.

July Survey.

THE POND.

A survey of the pond itself was next undertaken. In the pond were included the backwater of creeks and branches, the pools left by the subsidence of the pond, the pools and marshes not draining on account of the existence of the pond, the side pools of creeks and branches filled because they were backed up by the pond and left by its subsidence, and in short every collection of water which was due to the existence of the pond directly or indirectly. We wished to get the total effect of the pond in the production of collections of water, and hence of Anopheles.

Derivaux, who arrived two days before Le Prince and myself, used those two days looking for larvæ in the bayous between the dam and Smiths Creek with practically negative result so far as the pond was concerned. The gauge was 133 feet and less. The flashboards were put in the day before the full party began its work, and with this was coincident a sharp rise of the river. On the first day of search by the full party—July 18—the water was rising rapidly and was turbid with red mud. It was not reasonable to expect to find larvæ under such conditions, and none were found. "One culex" my record shows, in the bayous south of Smiths Creek, "in four hours' search" by the whole party. Small fish had been seen by Derivaux along the shore and up in the bayous. None were seen this day in the muddy water. The water was rising out of clean banks bare of growth into banks covered by vegetation mainly dead. "Two and a half feet higher than last night" is my note, "and 12 or 14 inches lower than the high-water silt mark on trees." The survey of the normal river valley above and below the pond was made while waiting for this rise to settle. The water reached 39.4 feet. The survey of the pond was begun after a three-day interval, when the gauge was at 38.3 feet.

This rise was due to heavy rains up the river, but there was also a sharp rainfall over the section of the pond on July 16, at night, washing out the creeks pretty thoroughly. This followed a long season of drought. It is necessary to know this to understand the situation.

As I have said, the banks of the pond, as far as examined—that is, from the dam to Smiths Creek, both river banks and in the bayous—had not been found breeding Anopheles before or during the rise, from July 15 to July 18, inclusive, nor, indeed, were any found on the north bank of the bayou of Smiths Creek on July 21, although the water had reached its maximum, 39.4 feet, on the 19th and 20th, and had begun to fall. On the same bank, however, on the afternoon of July 23 larvæ were found. None were found near the entrance of the bayou and practically none in the upper part of it. We were not able on this trip to go up to backwater, but pretty near it. They were found beginning from about one-fourth of a mile from the mouth to a point about one-half or three-fourths of a mile higher up. The larvæ were found generally one at a place. Sometimes two or three within a few yards. In two places, however, in bights at the mouths of drains they were fairly abundant, although the places themselves were small. Only at one of these last places were very small larvæ found. All were in "flotage."

FLOTAGE AND ITS RELATION TO PROTECTION OF LARVÆ.

By "flotage" is meant the small drift—pieces of bark and small sticks—which gathers almost like a scum on the water, resting against or near the bank or against brush growing close to the bank. We found it frequently sheltering mosquito larvæ, while the large pieces of driftwood rarely—or, at least, much more rarely—did so. Flotage tends to reach and rest against the bank. Wave action and wind and current all tend to bring it ashore, where, naturally, it will strand and be left above the water line as the water falls. The greater the disturbance of the surface of the pond the more rapid will be the general drift of flotage ashore, while if the surface be not disturbed at all it will naturally stay where it happens to be. The presence of thick brush, standing or fallen, next the bank will hold the flotage from the bank and thus prevent it stranding as the water falls. Naturally, too, it strands most readily on a gently sloping bank. It may follow a steep one down for some distance as the water falls, especially if it extends a little distance out from shore.

The source of flotage, as of all drift, is the river as it rises in a freshet. Some, of course, comes down the creeks into the heads of the bayous we have spoken of, but judging from the small amount seen about the upper reaches of these bayous this amount is but a small portion of what the bay receives from the river.

Coming down the main river, flotage collects along the banks wherever it can find a place to rest and, following the course of all drift in moving water, it goes up bays and bights and gathers in indentations. It goes a good way up a bayou, sometimes meeting that brought down by the creeks and landing against the banks, but is very much more abundant near their mouths. Of course it seeks the bank to the leeward. On such banks, unless the bank is very steep, it is driven up on the bank and stranded by wave action. Naturally, also, it lodges much more heavily on the lower shore of a bayou—the one down the river—than the upper one. I have already noted that the banks on the southern side of bayous—that is, down the river—were steep. Thus the bank which caught the most drift and flotage was the one on which it was most persistent and least apt to be stranded. The dead trees and brush left standing on this pond undoubtedly add to the flotage and at the places where it can do most harm—high up in the bayous—yet the proportion they gave compared with that furnished by the full river seemed to be small—very small. Little drift is found about the heads of bayous compared with their mouths. The standing brush does more harm by keeping the flotage away from the bank, and hence preventing it stranding as the water goes down. It will be interesting to see how much of this stuff will be standing in, say, three or five years. Its removal will have an influence for good on flotage and, of what nature I can not tell certainly, on the growth of aquatic vegetation.

During the first visit, July 21, to this shore, flotage was not observed resting against the shore. If it existed, it must have been in small amount, and at this time we did not find larvæ on the shore. There was flotage on the pond about the mouth of the bayou, south side, on July 24 and 25, but much more piled up on the bank, by wave action, and what remained afloat sheltered no larvæ. The record is "negative—two larvæ in one-third of a mile."

On July 18 and 21 the water was extremely muddy and no fish were seen on the banks of the bayou. On July 21, up near the head of the bayou where the water was clear, or nearly clear, from creek water, fish were fairly abundant. Down in the muddy water they were not visible, and I think were not present, as none were dipped up during a long day's work, while a number were caught in clearer water.

On the afternoon of July 23 where the water was shallow the edges were clearing on the north shore of Smiths Creek Bayou. On the edges there were fish, not in great number, but not scarce and very small; "over a dozen" were recorded as dipped up. In the upper part of the bayou they were plentiful. We did not reach to the creek above backwater in this trip, but fish were more abundant as we went higher up the bayou—in shallows and clearer water.

The south bank of this bayou was examined the next day, July 24, all day, and scattering larvæ were found in flotage, one, two, and three at a place, not enough at any place to be of sanitary importance—46 was the morning's catch of four dippers in 1½ miles of shore and some side streams. As before, none were found near the mouth of the bayou and very few in the upper part, where fish were very abundant and flotage was rare. The pond was falling and clearing slowly at this time, and the upper part of the bayou was clearing—from creek water—indeed, was quite clear some distance down from the mouth of the creek. Fish here were numerous. There were fewer fish on this shore than on the other, because the south shore is steeper and has fewer shallows. That part of Smiths Creek above the influence of the pond was breeding freely on July 21 and 24. No fish were seen in it above Forest Road, one-fourth mile above backwater.

In Buffalo Creek Bayou larvæ were found, save one or two, only on the bank, between *c* and *d*. This was on July 27, and only large adult larvæ, a few pupæ, and a few pupa shells were found. The flotage here was held away from the bank by thick brush and was sheltered from wave action. The bank was moderately steep. Only a few fish were seen. Elsewhere the flotage was stranded high and dry, as the pond had fallen considerably. No larvæ were found near the mouth of the bayou, which is very broad, and none toward its head nor in the backwater of the creek, both of which were alive with fish. The shallows in the zone of creek overflow were full of both fish and "water boatmen," some of which had also been seen in shallows on the north bank of Smiths Creek.

Across the river in the bayou of Barn Branch, not far from its head at *x*, enough larvæ were found to make a breeding place deserving sanitary consideration. These were in flotage against a steep bank with brush growing down into the water and well shaded. All were adult larvæ or pupæ, with some pupa shells. The place was protected from wave action, unless the waves came full in the mouth of the bayou. The creek above was breeding profusely. This was on the morning of July 28. We were driven from this place by a heavy wind squall. Examination the same afternoon showed practically no larvæ—three in an hour's dipping. The wind had been almost in the mouth of the bayou and had doubtless drowned them.

On the steep bank of the river next to a cliff where the water was nearly level with the bank—at *g*—a considerable number of larvæ of all sizes were found on July 23, in indentations of the bank where flotage had collected. We were surprised at this, because they were in fairly deep water. They were fairly abundant and were in three out of eight such places examined. A creek, not examined in July, but found to be breeding profusely in September, entered the pond some distance above, and there had been a sharp rain the night of July 21. This place was reexamined two days later and no larvæ could be found—about 25 or 30 places likely to hold them being examined in a distance of one-fourth of a mile or more. The flotage was still in evidence, mainly stranded by wave action, but enough left afloat to shelter larvæ had they been there.

All these observations are grouped together here to indicate the relation of flotage to mosquito production. Very obviously it protects the larvæ from fish. Fish, predatory aquatic insects, and wave action are doubtless the defenses of the pond against mosquito production and what protects the larvæ against these promotes such production.

ORIGIN OF LARVÆ FOUND IN FLOTAGE.

It seems evident that the larvæ we found in Barn Branch Bayou and in Buffalo Creek Bayou were washed down as larvæ and (probably) eggs and lodged in the flotage where they were found. There were no young larvæ among them—all adults and pupæ; none, we judged, under 8 days old. The creeks which flowed into the heads of the bayous (and which in the former place impinged directly on this bank) were breeding profusely all sizes, and there had been a freshet washing out the creek about 10 days before.

Le Prince and I felt that the same statement applied to those found on the steep river bank on July 23. It was a most unusual place for breeding, and the larvæ found in numbers on July 23 had disappeared on July 25. It is fair to say that the same thing applies to those found in Smiths Creek, viz, that they were washed down and sheltered in the places in which we found them. They were found widely and thinly scattered; in only two places were collections of larvæ found, and these where much drift had collected; generally they were single, or, at most, two or three in a pocket, and they were found only in flotage. There was no evidence of breeding on the shallow edges of the pond, even where grassy. Younger forms were found than in the bayous last mentioned, but the examination was made earlier—after a less interval from the rain, which flooded the creeks—yet in only one place did very small forms appear. Possibly in this place eggs may have been deposited where the larvæ were found.

There were no larvæ found close to the open mouths of the bayous and—except those mentioned as found on July 23—none on the banks of the open pond. This was doubtless due to these parts of the shore being exposed to wave action, which would quickly drown the larvæ. Against this, flotage is no protection. Very few, generally none, were found in the upper ends of the bayous near the creeks entering them, but none were examined until some days after the rain. There was very little flotage lodged up this high, and the water at the time examined was clear and full of fish and, being without shelter, larvæ cound not have been expected to be here. On the other hand, those that were washed down by the creek freshet, when the pond and creek were both muddy, with flotage passing down, could have passed this region safely and gone lower down the bayou and been sheltered in the flotage.

The other smaller bayous examined all contained flotage and driftwood and some of them a few larvæ—three or four to an hour's dipping—practically none. They were examined after Smiths Creek. No part of the bank of the pond, except that noted as examined July 23, showed larvæ. It is possible that had examination been made that day, just after a rain, they might have been found just below Naked Creek or Fish Dam or Nameless branches. They lasted less than two days where they were found July 23.

PRODUCTION OF MOSQUITOES.

From what we saw the development of imagos from the larvæ in the flotage was not at this pond of much sanitary importance. Indeed, the production of imagos in the bayous was very much less—beyond comparison less—than what were being produced in an equal length of creek and creek valley above backwater and which would presumably have been produced in the creek valley replaced by the bayou of the pond. Below the zone of overflow I doubt if there was any production in a sanitary sense on the banks of the pond proper as distinguished from the bayous, while the flooding of the flats, assuming they were like those in the river valley below and above the pond, covered large and productive breeding places. Below the zone of overflow, then, the production of Anopheles mosquitoes was enormously decreased during the time of our examination by the formation of the pond and at this time was not carried up the creeks.

COMPLETE AND INCOMPLETE BREEDING PLACES.

Only one place on the pond below the zone of overflow did we believe to be a complete breeding place; i. e., a place developing imagos from eggs deposited at that place. This was at the head of the bayou of Still-House Branch. Here there were found, July 28, larvæ of all sizes, some ready to pupate and some very young. They were in considerable number, although over a small area. Possibly the place found on the north shore of the bayou of Smiths Creek may also have been a complete breeding place, but it was considered doubtful at the time of examination.

The other collections of larvæ below the zone of overflow were, we thought, from eggs deposited elsewhere up creeks and branches and washed down to the places where they were found, and the places where they were found may properly be called "incomplete breeding places." In some such places, as in Buffalo Bayou and Barn Branch Bayou, the larvæ lodged there may develop into imagos, but are far less apt to do so than when breeding under normal conditions in marshes or sluggish streams, as evidenced by the observations at Barn Branch and the river bank below Mill Creek.

It seems fair to also call a place an incomplete breeding place when, although eggs are deposited there, yet imagos are not there developed from them; as in the pond at Hartsville, where although there were many small larvæ, yet adults in number sufficient for sanitary consideration were not found, on account of the fish; or as in a creek completely scoured out by a freshet—all larvæ being removed and either drowned or carried elsewhere. Such a creek might supplement an incomplete breeding place of the other kind in the flotage of a bayou at the creek's mouth.

ZONES OF OVERFLOW.

On the first examination, July 22, of the zone of overflow of the pond, it was below Coleman's Mill, from about A down to about half a mile above the mouth of Mountain Creek—gauge, 38.1 feet. Owing to the rise of the river, the water was over the meadows and all in the grass. It was extremely muddy and the grass was covered with silt. In the small streams running into it, where the water was clear, there were myriads of small fish; none were seen in the muddy water. There was no flotage. Anopheles larvæ were found, four in a bight of Mountain Creek, six in a ditch at the extreme upper edge of this zone, and quite a number in the old mill race—at one point only—under a bridge. We found none at all in the edges of the water, nor in the shallow pools running out from them, nor in the ditches or drains. There were quite a number of insects in the shallow water, which we afterwards found to be water boatmen. The larvæ in the race were very obviously washed from a small stream emptying into it just above where they were found. This stream was breeding profusely and was well above the influence of the pond.

We believed that this section would show Anopheles in a few days, as the eggs, which we judged had been and were being deposited, had time to develop. The only thing against it was the amount of silt which would be left on the grass and in the pools, and the chance of fish being left in pools as the river fell lower. Silt-covered vegetation is not favorable for Anopheles breeding, but a rain would probably wash it off and many pools would be left without fish.

This section was visited twice more during the next two weeks, and while physically changed—the river had fallen some feet—yet the conditions of Anopheles breeding were the same. The incomplete breeding place in the mill race had disappeared—July 25—and a few more were found in ditches, but none in the pools left by the falling water. These were full of water boatmen—sometimes as many as 20 would be taken at a single dip. Mr. Jennings, of the Entomological Bureau, tells us that these are Hemiptera and belong to family Corisidæ, genus *Corisa,* and feed on the larvæ of mosquitoes. They were abundant in open shallow water in many places about this pond, the bayous of Smiths Creek, Buffalo Creek, Naked Creek, etc., and wherever they were in number there were no mosquito larvæ. The drains and streams—fairly clear at the last visit—were full of fish, as were the edges of the overflow. Fish were also found in a number of pools cut off from the river. In some, nearly dried up, they were dead; in larger ones, alive.

On Bear Island, also in the zone of overflow, many Culex and some Anopheles were found breeding in pools left by the pond.

This was on the west side of the island toward its lower portion. The island is in two ridges, facing the river in each case, with a slough containing pools next to the western ridge. This place was in the woods and was breeding Anopheles enough to deserve sanitary consideration had it been near a residence. There were cattle on the island. There were also Anopheles breeding in some sloughs on the right side of the river, about H. The sloughs were, we thought, left by the river, or at least some of them were. They were breeding moderately freely.

The zones of overflow of the creeks and branches are about the heads of the bayous. They have been already considered. That they were not found breeding seemed to be due to the multitude of fish, and, to a less degree, water boatmen. Smiths and Buffalo Creeks especially were free from Anopheles larvæ in this zone and up to end of backwater, while some distance above it—above the influence of the pond—they were both breeding freely.

September Survey.

The September survey was made after a severe and long-continued drought. This was broken by heavy rains, one when we arrived and one 10 days later. On arrival Le Prince and myself discussed the matter and expected that on account of the drought such bodies of water as were left would be breeding more freely.

The results of the survey of the sections of the normal river valley above and below the pond have been given.

POND.

The water was low—135.4 feet was the highest on Monday mornings, and 131.2 feet the lowest on Saturday noons. The water was as clear as the Pedee River ever is. Below the zone of overflow the banks were bare for some feet above the water; no grass or vegetation of any kind, and practically no flotage or drift on the bank, except a little off the mouths of the bayous after the rains.

No larvæ were found on the banks of the pond proper. Practically no larvæ were found in any bayou, except in that of Jenkins Branch, of which I will speak later. It is worth noting that two bayous south of Smiths Creek were examined on the afternoon of September 17, and no larvæ found, the streams flowing into them breeding slightly above the influence of the pond. The work was stopped by a thunderstorm. The next morning larvæ were found in both bayous—scattered in ones and twos at the very places where none had been found the day before.

At Jenkins Branch Bayou larvæ were found in large number and all sizes among a small amount of flotage at the place marked I. This was 24 hours after a heavy rain, and a marshy area bordering a small stream just above this place had been flooded into this part of the bayou. The flotage was not enough to protect from fish, but no fish were seen here, although abundant in another part of the bayou. This place was revisited two days later and no larvæ found. The shores were swarming with fish.

ZONE OF OVERFLOW.

The zone of overflow was lower down the river than in July. Two visits were paid to this zone on the east side of the river. At the first one a few larvæ were found in a pool left by the river, hid in bullrushes, and some very young ones in rain-water pools in a section the pond water had been on. We knew it was rain water, because the bottom showed the wide cracks of dried mud, but counted this against the pond, as possibly seepage was interfered with.

Visiting this place seven days later these pools of rain water were found to have completely dried up, as indeed had the others. Larvæ were found in small number on this second visit in two drains running through this flat, but generally these were full of fish. Indeed, fish were in nearly all of the pools left as the water went down and were everywhere in the edges of the flow. The total breeding on this broad flat seen during these two days was insignificant.

Bear Island was breeding Culex much as it had been doing, but so many of the pools had scum on them that only a few Anopheles were found. Fish were in some of the larger ones that were clean. The area at H, noted as breeding on page 27, was not breeding at all in the pond area. All these pools connected with the pond were full of fish and all the old ones covered with an impenetrable scum; a number of pools filled with recent rain water—cracked bottoms—were breeding moderately outside of the pond area.

SMITHS CREEK.

At this time the backwater of Smiths Creek was very carefully examined, together with the bayou some distance below and the creek some distance above. This backwater and the zone of overflow of this creek were visited three times during September. The creek for over a mile above backwater was breeding freely or profusely. There were no fish seen in it except just above backwater. Backwater and the shallow pond area adjacent thereto were swarming with fish. Indeed, the same thing was true of the shores—both sides—of this entire bayou far more than in July. Water boatmen were less common than in July, but whirligig beetles, one of the Gyrinidæ, I think, were exceedingly abundant on the shores of the bayous in every indentation. These also destroy mosquito larvæ. None were ever found where there were any number of beetles.

Doubtless larvæ were washed down the creek by the rains in September as well as in July—they were found in the side pools which the creek had filled when it overflowed—but in July the pond was excessively muddy when the creek rose, while in September it was clear. The fish in the second case could get the larvæ as they came down, and in July they could not. Also, there was flotage to shelter them in July and very little in September.

The same examination, though less extensive, was made of the backwater and adjacent zones of creek and bayou for the other bayous of the pond. The same results were found. The creeks above pond influence were breeding, the backwaters and the bayous were not.

Conditions in July and September Compared.

Indeed, entirely contrary to our expectations, the breeding in the pond area on this visit was very much less than in July, due unquestionably to (1) the low water giving clean banks without flotage; (2) the very large number of fish which the clearness of the water enabled to find their prey; and (3) to a less extent to the number of predaceous aquatic insects, mainly whirligig beetles.

Similarly, it was against our expectations to find, in July, the steeper banks of the bayous harboring larvæ and, indeed, producing imagos, while the shallows on the gently sloping banks were free. We had expected the zones of overflow of the creeks to be especially bad—i. e., free breeding places—and the effect of the flotage we had not foreseen.

General Observations.

A certain number of larvæ and pupæ were kept and developed into imagos. It was at first intended to do this separately for each place examined. In the July survey this was not done. A number of collections were developed, however, showing *Anopheles quadrimaculatus* and *A. punctipennis*. Only one collection—that from Bear Island—gave only punctipennis. Near the power plant numbers of quadrimaculatus (imagos) were taken in the tents of some laborers and in the commissary. They were breeding in a branch near by.

In September the collections were kept separate. Bear Island again gave only punctipennis, as did one or two other places. The two species found in July were found, however, in nearly every breeding place. It is understood that "place of breeding" refers to a section of country, as Smiths Creek, Barn Branch, etc., including side pools and marshes adjacent, and not to an individual breeding place. No crucians were found.

In July practically no Anopheles were found in stumps, hollow logs, etc., in the wood. In September these were found, but were rather rare. No houses were searched for them in September.

Vegetation in the Pond.

LAND VEGETATION.

The land vegetation of the submerged area was dead—the grass and weeds were not only dead, but gone; the trees all dead; the brush dead, except the sweet gums and willows. When the rise in July came, although only for a few days, well above the normal level of the pond, many bushes were killed. This rise submerged many places covered with grass and weeds. These were killed and the line of flow could be seen in September by the dead vegetation. In the zone of overflow, where most of this submergence of meadows occurred, the greater part of the area submerged in July was left bare of vegetation in the low water in September—practically all of it except the edges. Covering vegetation by water, as in an overflow, naturally kills it, but one can not help thinking that this very muddy water, leaving a deposit of silt on everything, was more destructive than usual, i. e., killed with a shorter submergence. The dried deposit of silt on weeds was found to be fully one-fourth of an inch thick in September.

Of the bushes on the edges sweet gum and willows were the only ones to survive. The sweet gum seems to be more persistent than the willow. It grows along the edges of the bayous, even on steep banks, a few feet down in the water, and holds the drift and flotage away from the banks, and thus does harm. None was seen in the zone of overflow. Willows, on the other hand, are found almost exclusively in this zone, in the lower part of it only, on the old river banks and where a number of long islands are figured on the plat. In this flat country they do, I think, no special harm.

AQUATIC VEGETATION.

Other than algæ.—There was practically no aquatic vegetation in the pond. Even where swamps of cattails had been submerged they were dead. The pond was 2½ years old. How it will be when it is older is yet to be determined.

Algæ.—The pond was singularly free from algæ. Quite an amount of dead algæ was seen in July floating down the river as drift, and occasionally a piece of driftwood would be found with live algæ on it, but live algæ were very rare. Against such algæ-carrying drift, larvæ were occasionally found. Possibly the absence of algæ was due to muddiness of the water, but in September, when it was much clearer, algæ were still lacking. In pools and some sluggish streams above the pond influence it was not so rare.

Animal Life.

Besides the larvæ of mosquitoes the animal life which affected our problem was, as far as we could determine, fish, water boatmen, and whirligig beetles.

Fish were far the most important. They were more widely distributed and more constant. They were very abundant and at the places where they were most needed—as shallows; at the mouths of affluent streams; and left in pools as the water receded, and they usually lived as long as the pool lasted in the zones of overflow both of rivers and creeks. They were not common in very muddy water and did not get all the larvæ in flotage—what proportion we do not know; I think not many.

The beginning of the survey—July 16—must have coincided with the hatching out of a large lot of fish, for at that time many of them were extremely small—simply two eyes and a tail—not much bigger than an adult Anopheles larva. The average size increased by the end of July and was much larger in September. They were then, too, much more numerous. They were rarely seen in the creeks and branches except close to the pond. The only fish I saw caught from the pond—and in July the entire countryside was fishing—were catfish. Yet the little fish I saw in such numbers were not catfish, but scalefish.

The water boatmen—one of the Hemiptera—were found in multitudes in shallow pools and the shallows on the edges of the pond; more in July than September. They seemed to like water of high temperature. Where there were many we never found larvæ and soon ceased to look for them, and this before we knew that they were predaceous.

The whirligig beetles—Gyrinidæ—were not abundant in July, but were in myriads in September. They frequented coves and bights in the banks and were abundant on the edges of bayous. Fish were rarely found in number where they were abundant, nor any larvæ of mosquitoes.

There was another aquatic insect, a surface feeder, which was fairly common. This is what is commonly called a "slider"—sometimes a "water spider"—a long-legged insect which slides on the water, rowing itself along by its side legs. Whether it is predaceous or not we did not know. It is not unlike the water boatmen in general make-up. It was more plentiful in September than in July but never in great numbers.

Here, too, one might mention the larvæ of the mosquito Psorophora. A few pools in the zone of overflow were found on July 25 filled with these larvæ. Neither of the last forms are probably of importance as preying on Anopheles larvæ—they were not common enough.

Change of Pond Level.

This plant is partially shut down from Saturday noon to Monday morning, and also partially shut down at night. Thus there results a regular change in the level of the pond, independent of the rise of the river which supplies it. This nocturnal rise is from 9 to 12 inches; the weekly one 2 feet and upward. The variation was greater with low water—being in September 18 inches and 4.3 feet, respectively. The effect of this variation in level is discussed in the paper on Impounded Water, heretofore referred to, and will not be gone into here. The statement there made that it lessens the production of mosquitoes was abundantly borne out by our observations at Blewetts Falls.

Summary.

As a result of these studies, the following summary is presented:

(1) This pond has enormously diminished the area of breeding places of Anopheles, both next to the river and in the valleys of the creeks.

(2) During our examination in July we found only two places in the zone of overflow producing Anopheles in sufficient number to be of sanitary importance, one on Bear Island and one below it on the west bank of the river. In September this last place was not producing. It is fair to say that from the Bear Island breeding place only *A. punctipennis*—not considered to be a malaria vector—were found, and that both places were a long distance from any residence.

(3) The zones of overflow in the creeks were not found to be breeding to any extent (much less so, indeed, than the upper part of the creeks, themselves well above backwater). This was due to the number of fish which were present in these places and which, indeed, destroyed such larvæ as were washed down the creek in a freshet.

(4) Mosquito larvæ washed down from creeks, etc., lodged in the flotage of small stuff which drifts ashore in the pond and may undergo full development there. Outside of the zone of overflow this was the only place in the pond where mosquito production could take place. This was most marked during the survey in July—July 16 to 30—when the water was high. In low water this was not found to be the case.

(5) Wave action quickly destroys the larvæ in such flotage as it can reach.

(6) The only part of the pond in which this flotage contained larvæ over a few days was in the bayous of creeks and branches so far from the mouth of the bayou as to be protected from wave action.

(7) The production of imagos in flotage was small, except in a very few places (without sanitary significance); much less than would have been produced in the creek which had been replaced by the bayou.

(8) The change of level of this pond is an efficient deterrent to mosquito production, the fall of the pond leaving much flotage stranded and rendering larvæ more accessible to fish.

(9) Below the zone of overflow this pond when low, as in September last, was ill suited for producing mosquitoes, and was not producing them. This was due to (1) the naked banks—flotage being stranded ashore—and (2) the number of fish and predaceous insects next the banks, and especially in shallows and in the back water of creeks. The conditions for producing Anopheles were thus decidedly less favorable when the pond was low than when it was high.

It should be clearly understood that this summary is for the condition of this pond when we saw it in the summer of 1914. That its condition was different when it first filled is probable, and it may have been somewhat different last year; nor has it yet ceased changing. It may take five years longer for all of the dead brush to fall and decay, although I think but little will be left standing after three years more. When this has fallen, flotage will strand ashore more readily than it does now, and its rôle in protecting larvæ will be correspondingly lessened. What effect letting in the sunlight will have on the growth of algæ and to what extent the growth of aquatic vegetation will take place and affect the production of mosquitoes can be told definitely only by observations in future years, although surveys of ponds which have been in existence longer might throw light on the future of this one.